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OF
THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

DEVOTED TO THE ADVANCEMENT OF ASTRONOMY AND ALLIED SCIENCES

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VOL. XV, No. 3 MARCH, 1921. WHOLE No. 111

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THE JOURNAL

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ROYAL ASTRONOMICAL SOCIETY
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VOL. XV MARCH, 1921 No. 3

NEW STARS

BY J. R. COLLINS

(President's Address at Annual "At Home")

The fact that there are no less than five new stars, or their fading remnants, now visible is responsible for this discussion. It would seem probable that their number at this time appears above the normal, because the skies are being more carefully and systematically observed with continually improved instrumental equipment than hitherto, enabling such objects to be more readily located.

We shall undertake a brief historical sketch of the recorded appearing of these objects with their general characteristics, and mention a few of the problems that they may suggest.

The earliest record of the appearance of a new star is that observed by Hipparchus at Rhodes in the year 134 B.C., when a star was seen suddenly to blaze forth in the constellation Scorpio at a point where no star had been previously noted. This star was said to have appeared as bright as the planet Venus, and to have been visible in the daytime. Its going would seem to have been nearly as rapid as its coming, for in a short time it is said to have completely faded away. This was a most astonishing thing to Hipparchus for in his day the stars were regarded as definitely fixed objects representative of eternity—without beginnng and without end—and here was apparent evidence of both a beginning and ending of a star in a few days. This so impressed Hipparchus that he is said to have planned and carried to completion his great catalogue of stars as a reference chart for determining whether or

no any of the other stars were as transient as this one had proved to be. This new star, whilst not shedding much light on its own history, was the means of advancing astronomical knowledge, for as Hipparchus studied his charts and compared them with others previously made, without finding any evidence of change for 150 years in the direction he was looking, he discovered evidence of a shift westward along the ecliptic of the equinoctial points, a small but measurable amount. This was the discovery of the precession of the equinoxes, due, as we now know, to the slow but steady swaying of the earth's poles around a great circle 45° in diameter, once in twenty six thousand years.

It was not until nearly a hundred years after the star of Hipparchus had disappeared that we find record of another new star being seen, in the constellation of Ophiuchus in the year 123 A.D.

On December 10th, 173 A.D. one was reported as visible between Alpha and Beta Centauri, being very bright, shining with a strong scintillating light and being visible for eight months.

In the year 389 a new star was reported near Altair, the chief star in Aquila, as bright as Venus and disappearing in three weeks; but as a comet was due about that time and in that region, it would seem probable that the comet was mistaken for a new star. This observation may also apply to some of other records of early date.

In 393 another similar object appeared in the tail of the Scorpion.

In the year 827 a nova was recorded as being seen at the city of Babylon for a period of four months.

In May 1006 a monk describes a new star he observed in Scorpio.

In July of 1203 a new star, described as bright as Saturn, was seen in the tail of the Scorpion.

In 1230 another was noted in Ophiuchus.

In 1572 a new star burst out with extraordinary brilliance in the constellation of Cassiopeia. It was observed by the celebrated Danish astronomer Tycho Brahe, from his island home, and was described by him as being as bright as Sirius and at times being visible in daylight. It remained until March of 1574, when it totally disappeared after being visible for 18 months.

In 1604 Kepler observed a new star in Ophiuchus. It brightened, waned and disappeared in 15 months.

In 1670 a new star was observed by Hevelius and Gassendi, which they describe as having undergone some remarkable changes in brightness, and it disappeared in two years.

The faint star 34 Cygni underwent remarkable changes in light during the 17th century, but since then has remained unchanged, being just visible to the naked eye.

In 1848 Hind observed a new star in Ophiuchus.

In 1860 one was observed in the Northern Crown, known as Nova Coronae.

In 1876 Schmidt at Athens noticed a new star in Cygnus.

In 1885 a faint nova was seen in Andromeda by Hartwig, involved in the great nebula, but not bright enough to be visible to the unaided eye.

In 1887 a new star was discovered in Perseus by photography.

In 1892 a new star appeared in Auriga, visible for a few weeks, then it faded away.

We have now reached a period when the camera, the great telescopes, the spectroscope and other instrumental equipment enables the investigator in a measure to lay bare the secrets of the stars and compel them to tell their story in a way it was hitherto impossible to do and the number of observations and variety of results rapidly accumulate.

In the years 1893, 1895, 1898, 1899, 1890 and 1905 photographs of a number of these objects were secured in Norma, Centaurus, Sagittarius and Aquila.

With the application of the spectroscope to the question of these temporary stars the astrophysist has been enabled to learn more about them than could have been learned in centuries with the telescope alone.

The new star in Auriga discovered in 1892 by Dr. Anderson of Edinburgh, as well as Nova Cygni, and later Nova Persei of 1901 and the others, including those of 1918, 1919 and 1920, all show about the same behaviour in the fluctuations of light and changes of their spectrum at similar stages of their development. All, as far as it has been possible to follow them, exhibit a common type. Usually appearing involved in the milky way, they rise rapidly, increasing thousands of times in brightness in a very short time, then lose their light quickly for a time, and after several spasmodic

attempts to brighten up, sink to a luminosity indicative of a planetary nebula visible at their later stage only in great telescopes or after long exposure to the photographic plate.

Regarding the spectra of new stars two generalizations have been authorized, and since amply verified. One is that the spectra are mainly composed of dark and bright lines in pairs, emanating from the same substances but pushed asunder as if by the effect of swift opposite motions in the light-giving mass, one motion toward us and the other from us. The second is, that fading novae put on a nebular light-vesture, spectroscopically simulating minute "planetaries". Planetary nebulae were so named because the objects exhibit a more or less sharply defined disc, which was thought to suggest nebulous matter in a state of development towards the formation of planetary systems. Their light is found to consist mainly of three rays, composing the fundamental spectrum of all gaseous nebula. Of these three, the lowest, of wave-length 5007 is invariably the strongest. The intermediate ray, wave-length 4959, as well as the chief ray, are indicative of a hypothetical element termed "nebulium", a substance found in gaseous nebulae and nowhere else. The third line of the trio is independently faint or bright, indicating the undoubted presence of hydrogen in these formations, which constitutes one of the few links between nebular and terrestrial chemistry. Recent investigations in molecular physics seem to point to the posibility that "nebulium" may be but a transitory atomic condition of matter between hydrogen and helium, developed by the agency of forces grouped under the general term of radioactivity.

The usual behaviour of a new star, when at first increasing in brightness is to exhibit a continuous spectrum with dark lines, which would indicate that the star is surrounded with a cooler atmosphere or its equivalent. Then, as maximum brightness is approached or attained, bright lines also appear, duplicating the system of dark lines not superimposed but bodily shifted towards the violet end of the spectrum to such an amount as to indicate that the bright lines are emitted by the surface of the surrounding material which is being hurled towards us with enormous velocity —in many cases approaching or exceeding a thousand miles a second. Then the doubling disappears, gives way to broad bands

which become concentrated into the green of nebulium and finally reverts to whiteness, dispersing into an ill-defined prismatic band.

In the case of Nova Persei the light was found to increase 20,000 fold in the course of four days, and a day later dropped one third. Ritchey and Perrine's photographs show a motion of expansion of the nebulous material surrounding the central nucleus at the rate of 2′ in five weeks during a period of seven or eight months. Whilst persistent formations within the nebulous mass showed a tangential displacement of the same value, indicating rotational as well as expansive velocity approximating that of light. *Astrophysical Journal*, November, 1901. Van Maanen is 1920 finds a parallax of about 1/50 of a second for this nova, equivalent to a distance of about 150 light years. With most of the novae however, the distance is as yet problemetical.

It may well be asked, what is the meaning of all this and what does it interpret of the universe as a whole? Are they exceptional circumstances? Or do they indicate normal or abnormal processes in the development of stellar systems? From whence do they come and whither do they go? The complete answer is not yet, for the story has not yet been fully told. No explanation has as yet been offered which appears entirely satisfactory. Any reasoned theory of stellar development would seem to require great periods of time for accomplishment; but here we have in the sudden blaze of a new star and its rapid subsidencé, an apparent exhibition of the cosmical development, in the space of a few days or months, of a stellar system throughout the whole range, to which we usually ascribe in the orderly processes of nature aeons of time to amplify. The first and apparently obvious explanation was that of a collision of comparatively dark bodies in space in a grand catastrophe. That some such view was entertained by the contempories of Newton is indicated by the lines of Addison, written in 1700, as given in Cato's soliloquy:—

> "The stars shall fade away, the sun himself
> Grow dim with age and nature sink in years;
> But thou shalt flourish in immortal youth,
> Unhurt amid the war of elements,
> The wreck of matter and the crash of worlds."

Mathematicians tell us however that the possibilities of direct collision are remote, if not practically negligible. No doubt if such direct collisions were to occur the result might be somewhat similar to the outburst of a new star, but the subsidence of the resultant nebula, should require ages to accomplish instead of months. Bickerton has suggested that a grazing collision would produce the resultant of three bodies, one stationary, one retreating and the third advancing and dissipating in space. Bickerton sees in this, the form of rejuvenating the universe and arresting the dissipation of energy, through a sort of celestial mechanical perpetual motion. The fact of the doubling of the lines, which apparently indicate approach and recession of portions of the nova towards and from the earth, would require in this theory these collisions to be directed always in the line of sight to or from us. The improbability of this always being the case is so apparent, that the feasibility of such an explanation on general principles breaks down. As regards the perpetual motion idea it may seem strange and paradoxical that notwithstanding that perpetual motion has long been banished from the realm of mechanics, we still to a certain extent retain it in philosophy, even though we may have learned to interpret the universe on strictly mechanical principles, the science of which fundamentally prohibits the possibility of mechanical perpetual motion.

Professors Kapteyn, Seeliger and Wilson suggest that the rapidity of expansion is an etherial one, rather than material, the nova being enmeshed in a dark nebulous cloud that is successively lit up as the light traverses it from the penetrating star. Certain definite maintained formations have shown themselves in the development of the surrounding nebula to be in motion tangently as well as radially, which cannot be interpreted other than as matter being actually whirled outward with tremendous velocity. Notably, at any rate in Ritchey and Perrine's photographs of Nova Persei just referred to.

Very still maintains that what we see in the convulsions of a new star are actual outbursts of attenuated matter. The great difficulty of accepting this explanation has been that the immense velocities of translation far transcend any that matter has ever been known to attain. During the last few years the wonderful

world that has been opened to us by the physicist in the domain of radioactivity in which a whole solar system has been found miniatured within the compass of the old hard-shell atom, dashing about with velocities that in some cases would make themselves infinite in mass and time, seems to supply velocity enough to accompany the apparently rapidly expanding screen of vapour.

Tidal action of two bodies gravitationally drawn towards each other with high velocity but failing contact, it has been suggested, might be sufficient to cause the disruptive outburst in a somewhat similar way to that propounded for the formation of spiral nebulae. The fact however that opposite motions in the line of sight always appear and are characteristic of new stars would seem to indicate an expanding spherical shell rather than an expansion on a plane that in some cases at any rate, would not coincide with our line of sight.

The theory of the "new stars" appears as yet to be incomplete, and though much has been learned about them, there is every reason to believe that the near future will reveal still more.

What mighty thoughts overpower us, what great problems rush in upon us as we gaze upon the dazzling points of light as they pierce the blue of our little earth shield, ever beckoning us to come and listen to their story. What of space and time? The finite and the infinite and of the "mighty world of eye, and ear, both what they see and what they half create". Urania, as on our crest, ever points the way to further widening knowledge, conscious in our seeking that however illusive may appear a solution of the problem, whatever touches consciousness is knowable. Our world among infinities is relatively insignificant, yet has its inhabitant of five foot-six been able to outdo the powers of the gods of ancient Greece and Rome, as by artificial eye he pierces the abyss and reaches out across the gulf of space—that may require centuries for light to leap—and weighs and analyzes, the material of seething orbs thousands of times greater than our sun.

Has it not well been said:—

"And yet man, insignificant as he is, the sport of elemental war—the plaything of every pain that racks him,—uncertain of his existance for a single moment,—unable to decipher one step in the future he is about to travel,—he can lift himself from the dust

with a not unholy pride, and challenge the "dread magnificence of unintelligent creation." Ye heavens, Ye ponderous worlds: Ye cities of the trackless: And thou proud sun—Are we not greater than ye all; the subtleties of a universe of matter is as naught before a beggar's mind.

For a time we lay aside this leaf of nature's book with added wonder and added confidence in the power in which has been found "no variableness nor shadow of turning but which is the same yesterday to-day and forever".

ANNUAL MEETING

The Annual General Meeting of the Society was held in the Physics Building of the University of Toronto, at 8 p.m., January 14, 1921. The President, owing to illness was unable to be present, so the chair was occupied by the Vice-President, Mr. W. E. W. Jackson.

On motion, the minutes of the last annual general meeting, having been printed in the JOURNAL, were taken as read, and approved.

Miss E. M. Budd and Dr. J. B. Fraser were appointed scrutineers to count the ballots cast for officers to be elected at the present meeting.

Mr. A. F. Hunter, the General Secretary, presented and read his Report for 1920; and on motion by Mr. A. F. Hunter, seconded by Mr. H. W. Barker, it was received and adopted.

Mr. H. W. Barker, the General Treasurer, presented and read his Report for 1920; and on motion by Mr. H. W. Barker, seconded by Mr. A. F. Hunter, it was received and adopted.

Mr. A. F. Hunter, presented and read the Librarian's Report for 1920; and on motion by Mr. A. F. Hunter, seconded by Dr. J. Satterly, it was received and adopted.

Mr. A. F. Hunter, the General Secretary, presented and read reports received from the Montreal, Ottawa, Victoria and Winnipeg Centres; on motion by Mr. W. E. W. Jackson, seconded by Mr. H. W. Barker, the reports as read were received and adopted.

Mr. H. W. Barker, the General Treasurer, presented and read the financial reports received from the above mentioned Centres. On motion by Mr. W. E. W. Jackson, seconded by Mr. A. F. Hunter, the reports as read were received and adopted.

The scrutineers reported that 86 ballots had been cast, and that the officers elected for 1921 were as follows:—

Honorary President—Hon. R. H. Grant, Minister of Education for Ontario, Toronto.

President—J. R. Collins, Toronto.

First Vice-President—W. E. W. Jackson, M.A., Toronto.

Second Vice-President—Wm. Bruce, J.P., Hamilton.

General Secretary—A. F. Hunter, M.A., Toronto
General Treasurer—H. W. Barker, Toronto.
Recorder—J. A. Pearce, B.A., Toronto.
Librarian—C. A. Chant, Ph.D., Toronto.
Curator—R. S. Duncan, Toronto.
Council—Ralph E. DeLury, Ph.D., Ottawa; L. Gilchrist, M.A., Ph.D., Toronto; R. A. Gray, B.A., Toronto; A. R. Hassard, B.C.L., Toronto; H. R. Kingston, M.A., Ph.D., Winnipeg; Otto Klotz, L.L.D., D.Sc., F.R.A.S., Ottawa; Sir Joseph Pope, K.C.M.G., Ottawa; John Satterly, M.A., D.Sc., Toronto; Stuart Strathy, Toronto; Dr. W. M. Wunder, Toronto.

The scrutineers also reported that the proposed amendments to the By-laws had been approved by more than two-thirds of the votes cast, thus complying with Article VIII of the Constitution.

The amendments were as follows:—

By-law II.—Add the following:—The Council shall have power, upon a two-thirds vote of those present at a lawful meeting thereof, to remove from membership in the Society any member, whenever the best interests of the Society shall, in its opinion, seem to require such removal.

By-law VII.—Insert the word 'General' before 'Treasurer' in the heading and in the first line.

By-law VIII.—Insert the word 'General' before 'Secretary' in the heading and in the first line.

By-law XIII.—In Sect. 1, line, 2, insert the word 'twentieth' for the word 'fifteenth,' and add:— "At this meeting the officers of the Society shall make reports of all their acts and doings in the year. The Annual Meeting of each Centre shall be held before the fifteenth day of December in each year. At this meeting the report of the secretary and that of the treasurer, duly audited, on the work of the Centre for the year, shall be considered; and, after approval by the meeting, they shall be transmitted, before the 31st day of December, to the General Secretary of the Society."

Sec. 3 shall be renumbered Sect. 5, and two new sections added as follows:

3. Order of Business for Annual Meeting:—
   1. Reading of Minutes of last Annual Meeting.
   2. Report of General Secretary.
   3. Report of General Treasurer.
   4. Report of Librarian.
   5. Report of Curator.
   6. Election of Officers for ensuing year.
   7. Election of Auditors for ensuing year.

4. Suggested order of Business for an Ordinary Meeting:—
   1. Reading of Minutes.
   2. Business arising out of the Minutes.

3. Communications.
4. Reports from Council.
5. New Business.
6. Election of Members.
8. Librarian's Report.
9. Reports of Committees.
10. Predictions of Phenomena.
11. Reports of Observations.
12. Announcements—Paper for the next meeting.
13. Paper for the Evening.
14. Notes and Queries.
15. Adjournment.

The Chairman declared the above officers elected as the officers for 1921, and the amendments to the By-laws as passed.

Moved by Dr. J. B. Fraser, seconded by Mr. A. F. Hunter, that the following recommendation be communicated to the Council of the Royal Astronomical Society of Canada, for their action; viz., "We propose that the words 'acting upon the recommendation of at least a two-thirds vote of local centre', be inserted in the amendment to By-law II, after the word, 'Council'."—Carried.

On motion, a committee composed of the President, the General Secretary, the General Treasurer, and Prof. C. A. Chant, was appointed to devise ways and means of approaching the Dominion and Provincial Governments, with the view of increasing their annual grants to the Society, to $3,000, and $1,000, respectively.

On motion, Dr. J. B. Fraser, and Mr. A. R. Hassard, were appointed the auditors for 1921.

On motion, the President, and the General Secretary were named a committee to make arrangements for the annual "At Home" on January 25th.

The meeting was then adjourned.

J. A. PEARCE,
Recorder.

REPORT OF THE GENERAL SECRETARY FOR 1920

The membership of the Society has increased during the year, the following table giving the figures according to Centres, as shown by the Society's mailing list at January 1st, 1921:—

Centre	1918	1919	1920
Toronto	153	170	176
Guelph	20	19	18
Ottawa	68	75	92
Hamilton	14	11	10
Victoria	68	48	50
Regina	11	11	4
Peterborough	6	7	4
Winnipeg	18	20	48
Montreal	37	40	39
	395	401	441

In addition to these ordinary members, there are 20 honorary fellows, and 24 subscribers to the Journal who do not hold full membership, making a total membership of 485.

There have been 18 meetings held at Toronto during the Society's year just closed, at which the same number of addresses and lectures have been delivered, including an address on March 25th last by the distinguished astronomer, Prof. Edward E. Barnard.

Respecfuly submitted,

A. F. HUNTER,

General Secretary.

Mr. R. M. Motherwell, Secretary of the Ottawa Centre, reports as follows:—

The Annual Meeting of the Ottawa Centre of the Royal Astronomical of Canada was held in the Carnegie Library, Ottawa, on Wednesday, December 15th, 1920, at 8 o'clock. The President, Mr. C. A. Bigger, being unable to be present owing to a severe illness, the chair was occupied by Mr. A. H. Hawkins.

The minutes of the last meeting were read and approved.

A letter from the Professional Institute of Civil Servants was read, suggesting that the Institute might give publicity to the meetings of the various scientific societies in Ottawa and also prevent the occurence of two or more meetings on the same night. On motion of Messrs. Stewart and Henderson the matter was referred to the incoming Executive with instructions to interview the Secretary of the Institute as to the advisability of making the Astronomical Society dependent in any way on a purely Civil Service Organization.

The question of the best method to be adopted by the Central Executive in allotting grants to the various centres was discussed, the general feeling being that it was not a wise move to attempt economy by reducing the grant. The matter was passed on to the new Executive for consideration.

On motion of Messrs. Stewart and Nugent, the Secretary was instructed to draft a letter of condolence and forward it to the family of the late Thos. Fawcett.

The reports of the Treasurer and the Secretary were read and adopted. There are eighty-four active members and three life members.

Mr. A. H. Miller of the Dominion Observatory, Ottawa and Mr. F. J. Lambart of the Geodetic Survey, were proposed for membership and Mr. J. W. Wilson, of London, S.E., England, was elected to membership in the Society.

The following officers were then elected:—

President, Sir Joseph Pope, K.C.M.G.
Vice-President, Dr. R. E. DeLury,
Secretary, Dr. R. J. McDiarmid,
Treasurer, Mr. D. B. Nugent,
Councillors, Mr. A. H. Hawkins,
Mr. J. P. Henderson,
Dr. F. Henroteau.

With the past presidents, Dr. Otto Klotz, R. M. Stewart, M.A., F. A. McDiarmid, M.A., J. J. McArthur, D.L.S., and C. A. Biggar, D.L.S.

[Since the election of the foregoing officers, Sir Joseph Pope found himself not in a position to accept the office of President, and at a Council meeting of the Ottawa centre held January 7th, 1921, Dr. R. E. DeLury was elected President A. H. Hawkins, D.L.S., Vice-President, and E. A. Hodgson, M.A., Councillor.]

A vote of thanks to the retiring officers for their efforts on behalf of the Society was passed and the meeting then adjourned.

Report of the Secretary for 1920

During the past year there have been six regular meetings of the Society. As it was no longer possible to hold afternoon lectures all meetings were held at night in the Carnegie Library. The attendance at most of the meetings was good.

Owing to the severe illness of the President and the ill health of other members of the Executive there was only one fall meeting. As a result of the efforts of the Professional Institute of Civil

Servants the various scientific societies of the City may use the advertising space as offered by the Institute and this will in a large measure eliminate the clash of lectures of the various societies.

There have been twenty-two members elected during the year and very few resignations, leaving a larger membership than we have had for some years. It is with sincere regret and a keen appreciation of our loss that we record the death of Mr. Thos. Fawcett, a man whose membership was an honor to the Society. Mr. Fawcett was a Councillor for a number of years and his love of Science was manifested by his keen interest in the affairs of the Society.

The following lectures were given during the year:—

"What is Light," by J. P. Henderson, M.A.

"The Origin of the Earth," by T. L. Taunton, Ph.D.

"The Size and Figure of the Earth as Determined by Astronomy", by J. E. Ratz, B.A.Sc.

"Unequal Distribution of the Earth's Mass and its Effect on Astronomical Determinations," by F. A. McDiarmid, B.A.

"Winter Weather Controls", by Sir Frederick Stupart.

"Astronomy as a Practical Science", by R. M. Stewart, M.A.

President Falconer of the University of Toronto had consented to address the Society during the Spring Term but was unable to do so on account of an attack of influenza.

Respectfully submitted,

R. M. MOTHERWELL,
Secretary.

REPORT OF MONTREAL CENTRE

Number of members on the Roll 44, an increase of 4 during the year. There is however every prospect of an increase of membership during 1921 as the interest is growing. Four meetings were held. They were as follows:—On March 11th the Society was visited by Dr. Ralph E. De Lury, Research Astronomer of the Dominion Observatory, who gave a very able lecture on the Sun, illustrated by numerous lantern-slides. On June 10th, Mr. H. E. Asbury, Vice-Pres. of the Society, dealt exhaustively with the subject of Eclipses. On September 9th, Mgr. C. P. Choquette spoke on "New Methods of Measuring stellar distances," and Rev. W. T. B. Crombie gave a brief address on "the Constitution

and Structure of the Milky Way". The Society has to record with thanks a gift of lantern slides made by Dr. Otto Klotz, the Director of the Dominion Observatory. These, together with some others, were exhibited on the evening of the Annual meeting December 16, by the Secretary.

The following officers were elected for 1921.

President, Mr. H. E. S. Asbury; *Vice-President*, Mr. E. E. Howard, K.C.; *Sec.-Treasurer*, Rev. W. T. B. Crombie, M.A., B.D.; *Recorder*, H. E. Markham.

Council:—Mgr. C. P. Choquette, George Sample, F. R. Robert, Lieut.-Col. Lyman, James Weir, B.Sc., Miss M. Ellicott and John Corway.

At its last meeting the Montreal Centre decided that, seeing the Society was a little stronger financially the meetings would henceforth be held monthly. This, it is hoped, will still further stimulate interest.

Respectfully submitted,
W. T. B. CROMBIE,
Local Secretary.

SECRETARY'S REPORT, 1920, WINNIPEG CENTRE

During the past year a very earnest effort has been made to stimulate increased interest in the Society, with the result that the membership has increased from eleven to fifty-one. Thirteen meeting's have been held as follows:—

December 3, 1919—"The Sun"—Prof. L. A. H. Warren.
January 14, 1920—"Comets and Meteors"—Dr. H. R. Kingston.
January 30—"With the British Artillery in France and Flanders"—Prof. N. B. MacLean.
February 11,—"The Spectrum"—Prof. Frank Allen.
February 25,—"Ancient Astronomical Theories"—Prof. N. R. Wilson.
March 10,—"Color Photography"—Prof. V. W. Jackson.
March 24,—"Some Theories of World Evolution"—Prof. N. B. MacLean.
April 7,—"Star Clusters and Nebulae"—Mr. H. B. Allan.
April 21,—"Double Stars"—Prof. L. A. H. Warren.
May 12,—"The 72-inch Telescope and its Work"—Dr. J. S. Plaskett.
November 17,—"Time, its measurement and Distribution"—Prof. N. B. MacLean.
December 1,—"Is the Earth a Steel Ball?"—Dr. C. D. Miller.
December 15,—"The Bending of Light"—Prof. L. A. H. Warren.

Each lecture was illustrated with lantern slides.

H. R. KINGSTON,
Secretary.

Officers of Winnipeg Centre for 1921

Honorary President, Mr. Frank Powell,
President, Professor N. R. Wilson, M.A., Ph.D.
Vice-President, Mr. H. B. Allan.
Sec'y-Treasurer, Prof. C. D. Miller, Ph.D.
Council: Mr. Cecil Roy, Prof. N. B. MacLean, D.S.O., M.A., F.R.A.S.C.; Mr. C. E. Bastin, B.A.; Mr. E. J. Skafel, B.A.; Mr. Samuel Lowry.

Victoria

At the Annual Meeting of the Victoria Centre, held on December 14, 1920, the following officers were elected for the year 1921:—

Honorary President, J. S. Plaskett, D.Sc.
President, J. E. Umbach.
Vice-President, G. J. Burnett.
Secretary (pro. tem.), K. M. Chadwick.
Treasurer, J. P. Hibben.
Executive:—Mrs. W. B. Christopher, G. S. McTavish, A. P. Blythe, F. C. Green, W. E. Harper, A. Symonds, and past presidents, F. Napier Denison, A. W. McCurdy, W. S. Drewry, and R. K. Young, Ph. D.
Auditor, T. Shotbolt.

Secretary's Report

Since the Last Annual Meeting which was held on December 16th, 1919, there have been four ordinary meetings and an "At Home".

The following papers were read:—

1919 December 16—Development of Astronomical Research, by Dr. J. S. Plaskett.
1920 January 27th, Vagabonds of the Heavens, by Mr. W. E. Harper.
March 10, Science and the War, by Mr. H. H. Plaskett.
October 26th, Abnormal Weather Conditions of 1919 and 1920, by Mr. F. N. Denison.
November 26th, Our Moons and Other Moons, by Prof. S. L. Boothroyd,

Executive Meetings were held at 1122 Government St. on January 6th, March 10th, September 24th and December 10th. There have been nine new members during the year, and there are now 48 members on the roll. In order to popularize the society an "At Home" was held on April 20th, at "Comrades of Great

War" Rooms, when several interesting instruments and photographs were exhibited.

All of which is respectfully submitted.

K. M. CHADWICK,
Secretary.

FINANCIAL STATEMENT FOR YEAR ENDING DECEMBER 31, 1920

RECEIPTS.

Cash in Bank, December 31, 1919	$ 748.89	
Grant from Dominion Government	2,000.00	
Grant from Province of Ontario	600.00	
Grant from City of Toronto	100.00	
University of Toronto (50 Copies JOURNAL)	100.00	
Fees from members	796.01	
Sundry receipts (sale of magazines, etc.)	54.62	
		$4,559.75

DISBURSEMENTS.

Publication of "Journal" and "Handbook,"	$2,564.03	
Library account (books, etc.)	412.41	
Stationery, stamps and exchange	212.85	
Salaries (Ass't Librarian and Caretaker)	430.00	
Rent of rooms	120.00	
Grant to Montreal Centre	60.00	
Grant to Ottawa Centre	75.00	
Grant to Victoria Centre	100.00	
Grant to Winnipeg Centre	70.00	
Public lecture (University's proportion)	25.00	
	4,069.29	

LOCAL EXPENSES IN TORONTO.

Printing, Public Meetings	$40.51	
Barnard Lecture (part)	25.00	
Travelling expenses (McDiarmid)	25.00	
"At Home", Expenses	82.00	
Rent of rooms for meetings	35.25	
Stationery and Stamps	25.00	
Miscellanious charges	11.25	
	$244.01	
Balance on hand, December 31, 1920	246.45	
		$4,559.75

Respectfully submitted,
H. W. BARKER,
General Treasurer.

Audited and found correct
(Signed) A. R. HASSARD.
(") J. B. FRASER, M.D.

Librarian's Report.

During the year 1920 the Library has received a satisfactory number of accessions. Nearly all of our periodicals come as exchanges, and these may be tabulated as follows:—

From Canada and the Empire, 45 titles, total received..	245
" United States, 53 titles, total received.....	206
" Other Countries, 28 titles, total received.....	135
Total	586

Miscellaneous books added by purchase numbered 32. The chief additions, however, were the early volumes of the *Bulletin de la Société Astronomique de France*, an almost complete set of the *Annales* of the Paris Observatory, and a complete set of the *Astronomische Nachrichten* from 1823 to 1919, (209 volumes).

C. A. Chant,
Librarian.

Ottawa Centre, Financial Statement, 1920

Receipts

Balance on hand.....	$18.14	
Grant from General Council.....	75.00	
		$93.14

Expenditures.

Printing.....	$38.15	
Advertising.....	32.00	
Postage, exchange etc.....	3.38	
Telephone Tolls.....	1.75	
Wreath.....	5.00	
Janitor Service.....	5.00	
	85.28	
Balance on hand.....	7.86	
		$93.14

Examined and found correct
(Signed) D. Robertson.

Respectfully submitted,
D. B. NUGENT,
Local Treasurer.

December 15, 1920.

Montreal Centre, Financial Statement

Receipts.

Balance, Cash on hand, December 11, 1919	$ 70.08
Grant from General Treasurer	60.00
Members Fees	89.17
Interest on Bank Deposit	3.29
Total Receipts	$222.54

Expenditure

Cash sent General Treasurer	$ 86.67
Expenses of Lecturer	10.14
Expenses of Local Secretary as ordered by Council	16.85
Advertisement	3.00
Janitor's Expenses	6.00
Lantern Attendant	6.00
Postage and Commissions	8.47
Express on Slides	.35
Total Expenditure	$137.48
December 15, 1920, Balance, Cash on hand	85.06
	$222.54

Respectfully submitted,
W. T. B. Crombie,
Secretary-Treasurer.

Audited by
H. E. S. Asbury.

Winnipeg Centre, Treasurer's Report, 1920

Receipts.

Balance on hand December 3rd, 1919	$88.69	
Fees from 45 subscriptions for 1920	90.00	
Fees from 5 subscriptions for 1921	10.00	
Grant from Toronto	70.00	
Interest	1.14	
Total		$259.83

Expenditures

Remittances of fees to Toronto	94.00	
Expenses	83.82	
Total		$177.82
Balance on hand, December 15, 1920		$82.01

H. R. Kingston,
Treasurer.

Certified correct, December 15, 1920.
(Signed) C. E. Bastin,
" N. B. MacLean, *Auditors.*

Victoria Centre, Treasurer's Statement

Receipts.

1919 Dec.	16	Balance in Bank		$140.53
Dec.	31	Bank B.N.A. Interest		1.61
1920 May	30	Bank B.N.A. Interest		.22
July	19	Grant From Parent Society		80.00
Dues:	1	Member Pd. for 1917-18	$4.00	
	5	Members Pd. for 1919	10.00	
	24	Members Pd. for 1920	48.00	
	2	Members Pd. for 1921	4.00	
				$ 66.00
				$288.36

Expenditures.

1919 Dec.	10	Typing Reports, etc	$ 1.00
		"Colonist"	5.85
		"Times"	6.35
		Maynard, Lamp for Lantern	10.00
1920 Jan.	14	The 1919 Dues to Toronto	105.00
		'At Home' Expense Room	12.00
		Supper	45.55
July	15	School Bd., use of Room	14.00
Sept.	24	"Times" Account	15.75
		"Colonist"	30.15
Nov.	27	Prof. Boothroyd Travelling Expense	15.00
Dec.	10	Secretary, Stamps, etc	2.00
			262.65
		Bal. in Cash	4.00
		Bal. Bk. B.N.A.	21.71
			25.71
			$288.36

Accounts outstanding

Parent Society	$66.00
"Times"	3.28
"Colonist"	14.31
	$83.59

I hereby declare the above statement correct.

J. T. Shotbolt,
Auditor.

Victoria, B.C.
20th December, 1920.

THE INTERSTELLAR CLOUDS OF METALLIC GASES

By F. Henroteau

(*Concluded from page 70*)

A fact worth noticing, however, is that most of the wide lines in early class B stars are due to very light gases, such as hydrogen and helium, of very small atomic weight (1 and 4) and constituting most likely the outer layers of very extensive atmospheres. The atomic weights of calcium and sodium are respectively 40.1 and 23; among the ordinary lines of the star, the smaller the atomic weight, the wider the lines seem to be, a fact which is probably due to the distribution of the gases of the different elements in concentric layers. The mass of a B star, although great, seems however not to be much greater than that of the sun, perhaps four or five times, as results from the study of binaries; on the other hand its absolute brightness is enormous; could we not suppose that particles of the heavier metals could be shot toward space from the inner part of the star, such as particles are shot into space from the nuclei of a comet to form its tail, or such as particles are shot from the sun to form the solar corona, which stretches far into space. In other words, in the outer regions of the star's atmosphere, amidst the layers of helium and of hydrogen, some particles of calcium and of sodium would be diffused, and perhaps also some other metals. Their extreme tenuity would produce very narrow and sharp lines, although faint. These almost isolated atoms of heavier metals, on account of their inertia, due to their greater mass or their greater momentum, might only be disturbed slightly, sometimes almost not at all, by the less massive atoms of hydrogen or helium that surround them, and would only partly follow the motion of these gases in their orbital, tidal or pulsating motions.

A fact of considerable importance, along these views, is that in certain stars of early class B, the faint sharp K line of calcium is not completely stationary, but exhibits a variation of radial velocity having the same period as the variation deduced from other lines, but of smaller amplitude. This, of course, may be due as has been suggested independently by Schlesinger and by myself, to the blending of a K line produced in the atmosphere of the star and a

K line produced in an interstellar cloud. The fact that two K lines, one stellar and one interstellar have been found in novae, as well as in other stars, such as in π^5 Orionis, and the fact that in class B stars of the earliest types where the presence of stellar calcium is doubtful, and where the K line seems to be perfectly stationary, while the other lines oscillate, seems to point out that if a K line shows oscillation of smaller amplitude, this oscillation could be due to blending. If, however, when the amplitude of the oscillation of the stellar line is so great, that theoretically it might separate itself from the other line, we still see a single line, only partially displaced, then we might accept that *all the calcium causing the absorption is moving with the star*, as was said by R. K. Young[1]. The latter has suggested the hypothesis that a huge cloud of calcium surrounds the star, or the system of stars which is supposed to form a binary system; supposing that there are two condensations and that the cloud rotates around their centre of gravity with a period coincident with the revolution of the stars in the centre, it is possible, *according to Young*, to explain very nicely both the cases of apparently stationary H and K and those cases where these lines share in part of the variation of the spectrum by assuming different degrees of condensation for the calcium vapour; the phenomena can, however, be explained equally well by the pulsation theory, assuming that the absorption which gives rise to the calcium lines occurs at a very high level and that the outer layers of the calcium cloud are not greatly disturbed by the pulsation taking place in the core. A great many questions arise if one wishes to adopt Young's hypothesis. Why is the K line sharp and narrow when the motion of the envelope from the nuclei to its periphery has to change gradually from the motion of the star nucleus to being almost stationary, especially that the cloud is presumably denser near the star, than near its outskirts? Why should this huge envelope be made mostly of calcium and sodium, gases of rather high atomic weights, compared to the hydrogen and helium that form the star? Why should the period of rotation of the envelope be the same as that of the revolution of the binary system? This seems to be contrary to what we observe, for instance, for the sun, where different layers of gas have apparently different periods of rotation,

[1] *Dominion Astroph. Obs. Publ. 1*, p. 111.

and also to what has been observed by Campbell and Moore as to the rotation of planetary nebulae, where the S shaped lines indicate a very complex phenomenon.

The forcing of a small quantity, relatively speaking, of calcium and sodium atoms either by radiation pressure or by a phenomenon similar to that of the projection of α particles, would seemingly be a good hypothesis, for, the spectrum of a B star or of any star seems to be only the spectrum of its outer atmosphere, and the K line seems to indicate the presence of a very tenuous amount of calcium in that upper atmosphere. No doubt this hypothesis could only be accepted if the oscillation of a faint sharp K line is real in some cases, and not due to the blending, with it, of a K line of real stellar origin.

It was found before that in spectra of novae not only stationary H and K lines of calcium were found, but also stationary D_1 and D_2 lines of sodium. The presence of these stationary sodium lines was long suspected in early class B stars and it is only recently that their existence has been shown for the first time, by Miss Heger.[1] Many researches can be undertaken now, in order to prove some points of capital importance. Are the D lines always stationary or do they oscillate sometimes with a smaller amplitude than the other lines of the star's spectrum? Is the amplitude the same as that of the K line, or are the amplitudes related to the atomic weights of sodium and calcium? The latter being heavier would have a greater inertia, possibly would not be so much induced to follow the hydrogen particles of the higher atmosphere, and the K line would show a smaller amplitude than the D lines. Also a greater number of atoms of one substance would be driven in the higher regions and have, in these regions, a greater osmotic pressure (the osmotic pressure being equivalent to a very small density as to the production of absorption lines).

Taking for instance the K line, the ratio of its amplitude of oscillation to the amplitude of oscillation as given by the other lines might be a function of the osmotic pressure of the calcium, in these upper regions; adopting the above hypothesis, of calcium being driven in the upper regions, it seems possible that this osmotic pressure and consequently the ratio of amplitudes might be a

[1] *Lick Obs. Bull.*, 10, p. 59.

function of the absolute magnitude of the star, for, the brighter it is the greater quantity of atoms it will send in the upper regions. Hence if the parallaxes of the nearest B stars were determined *with some accuracy*, some work could be done along the above line to determine empirically the absolute magnitudes of other B stars, and hence their parallaxes. As far as this is concerned, the ratio of of the intensity of an ordinary line such as the helium line at He 4471, or the magnesium line Mg 4481, to the intensity of the K line or one of the D lines, might possibly serve, as in Adams' method, for classes F, G, K and M, to determine the parallaxes.

However, whether the faint sharp K line in early class B stars is of stellar or interstellar origin has not been definitely decided. On one side it is the possible oscillation of this line with the same period as that of the star, which is not definitely proved; on the other, it is the presence of sometimes two K lines of calcium, such is found in the spectrum of novae and π^5 Orionis, the apparent absence of a stationary line in the spectrum of θ Coronae Borealis, far from the Milky Way, and the inevitable presence of enormous patches of absorbing material chaotically distributed in some parts of the stellar universe. Something which tends to prove that that absorbing material could contain calcium is the following phenomenon which was discovered by myself in the study of the spectroscopic binary σ Cygni. The explanation I give of this phenomenon could, however, not be the right one and the effect again be due to some kind of blending of lines, but perhaps this explanation, given in the following paragraphs, might constitute a plausible hypothesis.

The spectroscopic binary σ Cygni (R.A.=21h 14m, Decl.=+39° 2′, spec. B8p., mag. 4.5), presents interesting peculiarities. Its spectrum contains a great many sharp and well-defined lines susceptible of very accurate measurements. Observations of σ Cygni were made by myself at the Detroit Observatory of the University of Michigan from June 12th, 1916, until October 22nd of the same year. During this lapse of time more than 100 spectrograms were secured, all on Seed 23 plates, with the one-prism spectrograph attached to the $37\frac{1}{2}$ inch reflector. As a rule the exposures were of forty minutes' duration. From the measures of these spectrograms an orbit was determined. All the details con-

cerning the measures and the physical study of this interesting star will appear in the *Publications of the Detroit Observatory.*

From the measures of the lines it was found that the hydrogen line Hϵ 3970.177 which is very near H 3968.625 of calcium, gives a velocity different from the mean velocity derived from the other lines of the star. We shall not give here the table of velocities, but

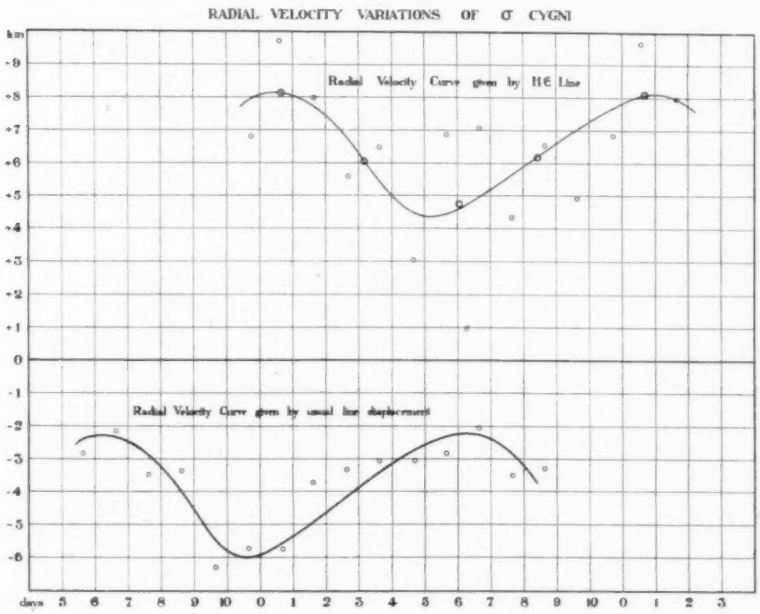

FIGURE 2

the accompanying diagram gives a fair idea of the radial velocity variations of σ Cygni, as given by the usual lines, and separately by the Hϵ line. There is no doubt from the accuracy of the measures, that the velocity variations derived from Hϵ are different from those obtained from the other lines. But there is no such difference for the well-defined H and K lines of calcium, and also no shifting of the other lines of hydrogen of which the whole series, Hβ, Hγ, Hδ . . . is visible in the star's spectrum.

No doubt this shifting of $H\epsilon$ is due to some cause, operating in the atmosphere of σ Cygni, or in space, between this star and the earth. The physical causes that may produce the shifting, and that are known up to the present, are: (1) pressure, (2) gravitation (Einstein's gravitational effect), (3) displacement of the luminous source in the line of sight (Doppler-Fizeau principle), (4) anomalous dispersion.

Probably pressure, gravitation and displacement in the line of sight have to be rejected as a cause of the displacements observed here, for if $H\epsilon$ is displaced, the other lines such as $H\beta$, $H\gamma$ . . . ought to be displaced also, and they are not. (It is also not probable that these different lines correspond to different layers of a hydrogen atmosphere). The same objection is perhaps no more applicable in the case of anomalous dispersion, for it has been proved theoretically, that two Fraunhofer lines situated very near each other, repel each other. The shifting of the lines, when they are very near, is of the order of 0.05 angstrom and at the distance which separates H and $H\epsilon$ it would be a repulsion of about 0.001 angstrom. But the displacement of $H\epsilon$ is greater than that; it amounts to about 0.5 angstrom. So, it is a more considerable displacement, and the repulsive action due to anomalous dispersion cannot account for it. Anomalous dispersion has not to be rejected however, since it is the only known phenomenon that may affect one line of an element and not the others, and possibly, if we couple it with another action, such as change of path or retardation of light propagation, a hypothesis explaining the displacement might be devised.[1]

Looking at the figure, giving the variations of radial velocities of σ Cygni, it is interesting now to compare the two curves. They indicate apparent velocities of the centre of mass completely different. While the star is apparently receding from us, the apparent centre of mass given by the line $H\epsilon$ is approaching us. But both curves have the same period and if we displace the star curve about 5 or 6 days along the time axis and then displace it again in the direction of positive velocities, we may bring it to coincide very nearly with the $H\epsilon$ curve.

Two questions arise now, that will be considered separately below: (1) Why is the $H\epsilon$ curve similar to the star curve displaced

[1] *Ap.J.*, 1916, p. 51 (January).

along the time axis? (2) Why is it similar to the star curve displaced along the velocity axis?

(1) (See Fig. 3), Let S be the star that we suppose in the calcium cloud. If behind it, a similar demonstration can be used. Let AB be the edge of the calcium cloud and let the observer be nearly at infinity in the direction MN or M′N′. The lights of all wave-lengths, except those near λ3933.833 (line K of calcium) and

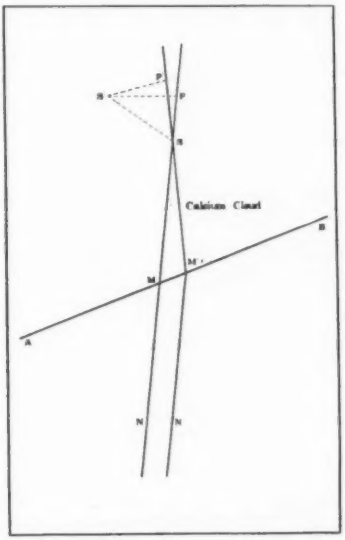

FIGURE 3

λ3968.625 (line H of calcium), will be refracted almost normally and follow the path SMN to reach us. The lights of wave-lengths $3970.177 \pm \Delta\lambda$ being very near H 3968.625 will be refracted abnormally, because the coördinate of the anomalous dispersion curve is greater than the refractive index of normal dispersion.

Thus, the light forming the absorption line Hε will follow the path SM′N′ in coming toward us. The absorption lines H and K will be found in their normal positions, since they are centres of symmetry relatively to the lights of wave-lengths $\lambda_H \pm \Delta\lambda$ or

$\lambda_K \pm \Delta\lambda$, for if $\lambda_H + \Delta\lambda$ is deviated one way, $\lambda_H - \Delta\lambda$ will be deviated the other way by the same amount.

For the line $H\epsilon$ and $H\epsilon$ only, there is a difference of path from the star to us. In general, the light forming $H\epsilon$ takes a longer time to come to us than the light forming the other absorption lines.

Let us now give an idea that the difference of paths may be five or six days, meaning that the light with its velocity of about 300,000 km in a second will take about six more days to come through the path SM'N' than through SMN.

From the estimate of the actual thickness of clouds in the Milky Way, as was done above for the photograph accompanying thi article, we may feel confident that the thickness of an interstellar cloud, supposed to be of calcium, is at least one light year. Let us now consider the possible magnitude of the angle MSM' necessary to produce a six light-days change under these conditions. The anomalous dispersion of calcium vapour has been studied by Puccianti, Schön and Geisler, while the anomalous dispersion of sodium has been carefully investigated by R. W. Wood.

If we compare the photographs giving the anomalous dispersion of sodium and that of calcium published by Puccianti, in his article "Metodo interferenziale per la studio della dispersione anamola trei vapori"[1] we see that the anomalous dispersion for calcium is of the same order as that for sodium. Moreover H. Geisler in his article "Zur anomalen Dispersion des Lichtes in Metalldampfen"[2] says that the anomalous dispersion in the neighbourhood of the H and K lines is great, although not so great as that around the D_1 and D_2 lines of sodium. The dispersion curve for calcium may be represented roughly by fig. 4.

It is now easily shown, by taking account of the most probable enormous size of the calcium cloud, and by the data obtained from laboratory experiments, and also theoretically by applying, for instance, Sellmeier's formula of dispersion, that the angle MSM' need only to be very small to produce a difference of path of six light days, and that a phenomenon as supposed above is largely in the domain of possibilities. The shifting of the $H\epsilon$ curve along the

[1] *Mem. Soc. Spettr. Ital.*, *33*, 133-138, 1904.
[2] *Zs. f. wiss. Photogr.*, *7*, 89-112, 1909.

time axis, a distance equivalent to six days may thus be accounted for. (More detailed explanations will be given in the *Publications of the Detroit Observatory*).

(2) Why is the $H\epsilon$ curve displaced along the velocity axis with reference to the star curve?

If we now suppose that the centre of mass of the star S (see fig. 2) is moving in the direction SS′, we know that the displacement of the lines, due to the Doppler's effect, is proportional to the increase of path length. This increase will evidently be different

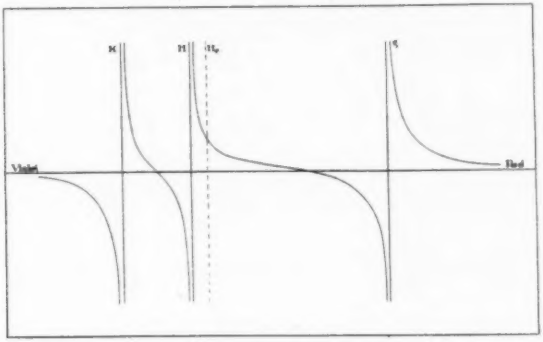

Figure 4—Approximate Anomalous Dispersion Curve of Calcium
(*Not to scale*)

for the two paths SMN and SM′N′ (proportional to the projections of SS′ on SM and SM′ respectively). Here also, it is easily proved, as has been done for the *Publications of the Detroit Observatory*, that a difference of 10 km between the mean velocity of the star curve and the mean velocity of the $H\epsilon$ curve can be accounted for.

The above study concerning σ Cygni is of course only a very first step for showing that extensive clouds of metallic vapours might have the indicated influence. If a complete study of this star was undertaken with a large telescope and a large dispersion spectrograph, *i.e.*, with astronomical equipments such as those of Mt. Wilson or of the Dominion Astrophysical Observatory, and if the above phenomenon of the shifting of the $H\epsilon$ curve was verified, as well as found in other stars, it might prove to be of capital importance.

Before ending the present article it remains to be said as has been pointed out by Professor H. N. Russell[1] that in the regions of the sky where selective absorption may occur, it would be worth while to compare the colour indices of the stars with their spectral classes. It is interesting in this connection to note that the three most abnormally yellow stars of class B (ζ, o and ξ Persei) lie within 5° of one another, in a region full of diffuse nebulosity. Most likely the violet light has been greatly absorbed by the nebulous clouds.

The fairly frequent apparition of novae in some regions of the Milky Way and the existence of a rather large number of irregular variables in these regions, which could be best explained by the disappearance of stars behind drifting gas masses, cutting down their brightnesses in such a way that it is not rare to see these variables have amplitudes of more than five magnitudes, *i.e.*, being sometimes more than one hundred times less bright than at other times,—could be very good indications of extensive regions of great absorption of light.

[1] Some Problems of Sidereal Astronomy, *Proc. Nat. Ac. of Sc.*, 5, 391-416, 1919.

Dominion Observatory, Ottawa,
November 18th, 1920.

P.S.—As the present article is going to press I have read Dr. Young's paper published in the last December number of this Journal on the calcium lines H and K in early type stars. I beg to point out that I differ with him as one can see already from my present article.

First, from the 37 stars given in his Table I, only seven are indicated as having an amplitude of the K line velocity different from zero and different from the velocity amplitude given by the other lines; they are Nos. 1, 7, 9, 10, 12, 23 and 33. The case of 9 could be explained by the fact that the general lines of the spectrum of that star are very wide and unsymmetrical and hence, when measured, give an amplitude different from that of a K line (which is a stellar line, but better defined). The cases of 7, 12 and 23 have been explained by F. C. Jordan as being due to the blending of a stationary and an oscillating K line, (an interstellar and a stellar, as they are called above). The case of 10 is absolutely peculiar: very long period binary and also different velocities for the different lines, as was pointed out by Rufus. As to the remaining cases 7 and 33, they could be due

to the blending of two lines. Hence *there is no simple case in which the smaller amplitude of stationary K line is demonstrated not to be due to some peculiar effect, such as the blending of lines.*

As to Young's great objection (p. 395) to Hartmann's suggestion, it naturally falls down, as explained in my article; and as to the important observation of H. H. Plaskett mentioned by Young (p. 397) of two class B stars (one of earlier type than the other) only a few seconds of arc apart, one shows an interstellar calcium line and the other, a stellar line. (It is well known that the stellar line is non-existent in very early types and increases in intensity when we advance in the spectral classification, to culminate as a very wide K line in class F stars.)

F.H.

NOTES FROM THE METEOROLOGICAL SERVICE

Temperature

The temperature was about average over a large portion of British Columbia and in the extreme northern portion of Alberta, also in Cape Breton, elsewhere it was above the average and to a very marked extent in Saskatchewan, Manitoba, and Ontario, where the positive departures varied from 6 to 10 degrees.

The following are the highest and lowest temperatures recorded at the various stations.

TEMPERATURES FOR MONTH OF JANUARY, 1921

STATIONS	December Highest	Lowest
Yukon		
Dawson	18	−50
British Columbia		
Atlin	36	−34
Agassiz	49	25
Barkerville	34	− 4
Kamloops	47	7
New Westminster	48	25
Prince Rupert	48	14
Vancouver	47	24
Victoria	52	29
West Provinces		
Battleford	37	−25
Calgary	46	−14
Edmonton	41	−33
Medicine Hat	46	−10
Minnedosa	32	−36
Moosejaw	41	−15
Oakbank	33	−37
Prince Albert	30	−36
Qu'Appelle	38	−26
Regina	36	−25
Saskatoon	39	−22
Souris	33	−27
Swift Current	50	−12
Winnipeg	33	−33
Ontario		
Agincourt	50	− 8
Aurora	46	− 9
Bancroft	45	−37
Barrie	45	−12
Beatrice	42	−33
Bloomfield	42	−15
Chapleau	35	−32
Chatham	53	7
Clinton	46	− 1
Collingwood	40	−12
Cottam	..	..
Georgetown	46	−12
Gravenhurst	45	−30
Grimsby	50	0
Guelph	46	−11
Haliburton	43	−38

STATIONS	December Highest	Lowest
Ontario—cont.		
Huntsville	41	−33
Kenora	34	−28
Kingston	43	−15
Kitchener	46	− 9
London	48	2
Lucknow	44	− 8
North Gower	49	−20
Oshawa	38	9
Ottawa	44	−23
Paris	50	− 6
Parry Sound	44	−28
Peterborough	46	−19
Port Arthur	40	−20
Port Burwell	44	− 3
Port Dover	48	− 1
Port Stanley	48	2
Queensborough	47	−33
Ronville	43	−38
Southampton	46	0
Stonecliffe	44	−34
Stoney Creek	52	− 3
Toronto	53	− 5
Uxbridge	45	−16
Wallaceburg	45	− 1
Welland	50	− 5
White River	39	−43
Quebec		
Brome	43	−24
Father Point	41	−14
Montreal	36	−13
Quebec	38	−16
Sherbrooke	42	−17
Maritime Provinces		
Charlottetown	44	− 2
Chatham	48	−20
Fredericton	44	−17
Halifax	48	− 2
Moncton	51	− 9
St. John	47	− 5
Sussex	50	−14
Sydney	46	− 6
Yarmouth	46	−16

PRECIPITATION

The precipitation was excessive in nearly all parts of British Columbia, with a very heavy snowfall on the mountains. In the northern portions of Alberta there was also a positive departure while over the large remainder of the Dominion there was a deficiency which was in most places very marked. Some of the more noticeable negative departures were at Parry Sound, 2.06 inches; Toronto, Ont., 2.14 inches; Kingston, Ont., 2.37 inches; Woodstock, Ont., 2.96 inches; Mount Forest, 2.59 inches; Montreal, Que., 1.95 inches; Yarmouth, N.S., 2.36 inches; Halifax, N.S., 1.85 inches.

MAGNETIC DISTURBANCES, DECEMBER, 1920

The month of December was exceptionally quiet magnetically. Only one disturbance of magnitude was recorded at Agincourt and Meanook and it was of very moderate intensity. At Agincourt the Ranges recorded in the different elements were: D 52′.7, H 166γ and Z 124γ. At Meanook the Range in Declination was 4° 17′.

The month was also marked by the sparsity of records of the aurora. This was particularly pronounced during the latter half of the month.

Sunspots were generally small, few in number and widely separated.

W. E. W. J.

SEISMOLOGICAL NOTES, JANUARY 1920

Toronto recorded eleven disturbances, and Victoria twelve. This is about four greater than the normal number. January is generally a month of large disturbances, but the largest trace amplitude at Toronto this month was only 0.5 mm. on the 9th and 0.8 mm. on the 20th. The others ranged from 0.1 to 0.3 mm.

Since our account of the earthquake of December 16th which appeared in the last issue, some remarkable reports have been received from Northwest China, the district affected by the disturbance.

There was great loss of life in the provinces of Shansi, Shensi, Kansu and Szechwan, thousands being killed and injured in the counties of Fukiang, Chingan and Chinghsui, also in the city of Tsinchow where hardly a building was left undamaged, fully 40% being completely demolished. The majority of the people were thus obliged to live outside and they erected tent-like places of bamboo mats or cloth. Besides the damage by shock, fires added to the danger, and many buildings were entirely destroyed in this manner. In nine hours after the first shock, which was the severest, there were thirty-five distinct tremors, and the people slept in their clothes ready to run quickly if necessary. In the Pingliang district alone, the death toll is estimated as being two thousand. Outside Kingchow the hills fell into ravines and valleys, burying alive hundreds of people and their animals including a whole caravan of camels. In one place the streets opened, causing the houses on both sides to fall together; in another, black water gushed from the ground. Many towns are said to have been swallowed up in the earth's opening.

J. Y.

MEETINGS OF THE SOCIETY

At Toronto.

January 4, 1921.—Mrs. L. D. Hargreaves, 181 St. Clemens Ave., North Toronto, was elected a member.

Under the heading of "Observations" Mr. A. F. Miller spoke of the present low barometric pressure. At the last meeting, December 14th, he called attention to the same condition existing then, stating that some authorities attribute the cause of certain earthquakes to sudden changes in barometric pressure. On the morning of the 15th, he noticed a peculiar coloration of the sky, and found upon observing with a spectroscope the presence of those bands in the solar spectrum due to water vapour, and hence seen when the barometer is low. An earthquake occurred on the same day. Mr. W. E. W. Jackson remarked that as pressures are usually local and the earthquake occurred in Chile it is hard to understand the connection between the low pressure over Toronto and the earthquake in question.

Prof. C. A. Chant, referring to the recent determination of the angular diameter of the star Betelgeuse, stated that thirty years ago Prof. Michelson of Chicago announced a method of measuring the diameters of small bodies by means of his interferometer. The method recently employed was an application of this.

The paper of the evening was given by Mr. W. E. W. Jackson of the Meteorological Office, his subject being "The Secular changes in the Magnetic Elements."

The lecturer gave a brief but comprehensive history of the growth of our knowledge of Magnetism. According to tradition, the polarity of a magnet was known to the Chinese nearly three thousand years before the Christian Era. A legend relates that in the 64th year of the reign of the Emperor Ho-ang-ti (2634 B.C.) he attacked the rebel Khiang on the plains of Tchoo-Loo. Khiang getting the worst of the conflict, raised a great fog in order to throw confusion in the ranks of his adversary. Ho-ang-ti was equal to the occasion however and constructed a chariot which indicated the South, and thus was enabled to pursue Khiang and take him prisoner. It is certain from their literature that the Chinese used the compass in navigation and were aware of magnetic declination centuries before Europeans.

The earliest record we have of the use of the compass in Europe is towards the end of the twelfth century. Soon after its introduction, laws were formulated against the falsifying of the compass. One of the commonest beliefs which prevailed for many centuries was known as the 'garlic myth' and mariners were charged not to eat onions or garlic lest the odor deprive the stone of its virtue by weakening it, and so prevent them from preserving their correct course.

About 1300, Gioja of Positano, Italy, invented the mariner's compass and introduced the card of thirty-two points. At this time in Europe it was generally believed that compass bearings were true bearings, *i.e.*, they believed the compass

pointed true to the pole. It was Columbus who discovered the fact that the needle changes its direction from place to place. He crossed the agonic line on September 13th, 1492. By the 17th, his compass varied to the north-west a whole point. As the seamen were terrified, Columbus practised some pardonable deception upon them by changing the card, and stating that the star had moved from its opsition, but that the needle had remained stationary. Cabot discovered another point on the agonic line in 1497. This line for many years was believed to be a line of demarcation given by Nature from which to measure longitudes.

In 1576, Norman discovered the dip of the needle, and with great precision determined the value of this element at several places in England.

In 1600, Dr. Gilbert published his famous work entitled "De Magnete," the most complete summary of the properties of magnetic bodies to that date. According to Gilbert, the earth is a great magnet having its magnetic poles coincident with its rotation poles. In fact, he regarded the earth rotation as due to magnetic action.

The next great contribution was made by Gellibrand, Prof. of Mathematics at Gresham College, who in 1634 announced the fact of secular variation in declination.

Nearly three centuries have passed since Gellibrand's discovery was made known, and although observations have been multiplied and some of the best minds have given their undivided attention to this most striking fact of the earth's magnetism, the riddle is still unsolved. Observations of dip are not so numerous and those of intensity are still more scarce, beginning only in the early part of last century, after Gauss had turned his analytical mind to the problem and developed the formulae and method of observing.

Baron von Humboldt, through the British Association, pursuaded the British Government to establish fixed observatories for the purpose of investigating the magnetic phenomena; and one of the results of his efforts was the establishing in 1839 of the Toronto Observatory.

A copy of Gilbert's book "De Magnete" was exhibited and examined by the members.

January 25, 1921.—The Annual "At Home" of the Society was held in the auditorium of the Physics Building of the University, at 8 p.m., the re-elected President, Mr. J. R. Collins in the chair.

The President, after welcoming the members and their friends gave an interesting address upon "New Stars". He mentioned the chief novae which have been seen from the time of Hipparchus, stating the constellations in which they appeared, the dates of their discovery, and the period of their visibility. He discussed the phenomena peculiar to new stars, and showed by slides certain phases in their development.

After his address the president spoke briefly of the aims of the Society, its organization, and summarized its activities during the past year. He then read the names of the newly elected officers for the year 1921.

Prof. L. Gilchrist exhibited a Michelson Interferometer, and described at some length the celebrated Michelson-Morley experiment, the results of which

are contradictory to the explanation of abberration. A model, constructed by Prof. Satterly, illustrating the phenomenon of abberation was shown. In seeking to reconcile the opposing results a new conception of the fundamental principles of space and time has been developed in the theory of Relativity.

The Meeting adjourned to Room 41, where Dr. J. Satterly gave a most interesting and amusing demonstration of the properties of liquid air. Many varied experiments were performed to show the peculiarities of this bluish liquid, whose temperature as measured by a pentane thermometer was found to be −332° F.

After refreshments had been served, the pleasant evening was concluded by an examination of the exhibits arranged in rooms 18 and 43, among which were;—specimens of Mr. A. R. Hassard's reflecting mirrors; several spectroscopes in operation, and a new model of the sun, earth, and moon, devised by Dr. W. Wilson of London, England constructed to accurately show the various motions of these bodies.

February 1, 1921.—The following were elected members of the Society:—

Miss M. M. Barnard, 17 Roxborough Street West, Toronto.

Rev. E. D. Robinson, M.A., Hamilton, Bermuda.

Prof. Alexander McAdie, Director of the Blue Hill Observatory, Readville, Mass., U.S.A.

Prof. C. A. Chant, gave the lecture for the evening, on "The Planets and their Ways"; this being the first of a series of three popular lectures.

The first planet to be discussed was the Earth. The question of its shape was considered at some length. Many observations were explained which prove that the earth is curved and not a plane. The celebrated experiments of Alfred Russell Wallace, on the Bedford Level, England, were described. Pictures of this old canal were shown, among them a series of three photographs showing the bridge where Wallace performed his experiments, taken at three different heights above the water, and from a distance of six miles, which plainly showed that curvature existed.

Prof. Chant pointed out that there is always an element of uncertainty in the observations made over water to demonstrate the earth's curvature, due to the fact that the observer is looking through a long layer of atmosphere, the refraction of which is nearly always indefinite. He showed some drawings he made a few years ago, of the sun setting over the Pacific, the sun's disc being distorted into many curious and strange shapes. By a mere coincidence he received only that morning a letter from Mr. B. S. Wimbush, Garden Plain, Alberta, inclosing drawings of a recent observation of the same phenomenon, and many of them were similar to those made by the lecturer.

The fact that the predictions of eclipses are precisely fulfilled decisively proves that the earth is a sphere, that it rotates upon its axis and that it revolves around the sun, since all these conditions enter into the computation.

The planets Mercury and Venus were next described. A model illustrating the phases and elongations of inferior planets was exhibited. References were made to the coming elongations of these planets, the observations of which should prove interesting.

The peculiarities of each of the outer planets were discussed in turn, and the planet's apparent paths among the stars for the year shown. The attractive planet, Saturn, was described more fully than the others, the lecturer explaining the nature and varing appearances of the ring system, which, just at present is invisible to us.

February 8, 1921.—The following were elected members of the Society:—

Mrs. A. M. Reinhardt, King Edward Hotel, Toronto.

Mr. F. C. Hamilton, 415 Ontario Street, Toronto.

As this was not a regular meeting, the usual order of business was dispensed with: and the entire evening devoted to the lecture, "The Moon and its Service to us", the second of Prof. Chant's series.

Prof. Chant, first gave a number of references to the moon in poetry, to show that some poets are accurate observers and describe the moon carefully, while others are careless of astronomical facts. Slides were shown illustrating the changes in phase during a lunation. The question of the moon's influence upon our weather was discussed, it being demonstrated that the possibility of the moon holding water depends upon the moon's position in its orbit, as the line joining the cusps is always perpendicular to the sun's rays. A number of slides were shown illustrating the various fanciful figures seen in the full moon, such as, "The Girl's Head", "The Lady Reading", "The Crab", "The Donkey" and "The Old Man." The occultation of a star by the moon, one of the most interesting of observations, was described, photographs of the occultation of Aldebaran, Alpha Tauri, being shown. In addition to its light, the moon's chief service to us consists of its action in producing the tides. The lecturer concluded by making a survey of the moon's features, pointing out the most characteristic craters, mountain ranges and prominent seas of our interesting satellite.

February 15, 1921.—Prof. Chant, gave the third lecture of his series, his subject for the evening being, "News from the Stars".

The lecturer, first defined the term *magnitude*, and developed the law of the "light-ratio" of stars. By means of a number of candles, he compared the light from typical stars of the first four magnitudes, showing that a first magnitude star was equivalent to 2.5 second magnitude stars, 6.25 third magnitude stars and 16 fourth magnitude stars. He next discussed the change in brightness due to change in distance, showing that by removing a first magnitude star to a position ten times its present distance, it becomes a sixth magnitude star. Thus, our sun whose magnitude is 26.3, becomes a faint 4.7 star, when removed to a distance of 10 parsecs (32.6 light years).

Prof. Chant then briefly described the classification of stars into the spectral types, B, A, F, G, K, M; and explained Russell's theory of giant and dwarf suns, according to which, stars of type M whose absolute magnitude is large, must be tremendous in size, and therefore very probably gaseous in character. The star Betelgeuse is such a star, being ruddy in colour, of magnitude 1.0, and of type M. Prof. Michelson of Chicago, selected this giant sun and succeeded in measuring its diameter.

The lecturer described Michelson's method, introducing the subject by a brief outline of the principles of interference and diffraction, exhibiting a number of slides showing the fringes obtained by various methods. He explained the resolution of double stars, and gave the resolving power of a telescope as $1.22\ \lambda/D$, where λ is the wave length of light used, and D is the diameter of the objective. In 1890, Prof. Michelson devised the following method of measuring the diameters of small bodies. He placed a screen with two slits in front of the objective of the telescope, and receiving the light passing through these slits and then through the telescope he obtained fringes at the focal plane. When he used a disc instead of a point source, the fringes became fuzzy, and by suitably adjusting the slits in the screen, the fringes could be made to disappear. When this occurred, the angular diameter of the disc was given by the formula, diameter $1.22\ \lambda/D$. In this way in 1891 he measured the diameters of the satellites of Jupiter.

Although he announced in 1890 that this method might perhaps be used upon stars, he did not attempt any work in the line until last year. Taking Russell's statement of the probable size of Betelgeuse, he tested his method with the 100-inch reflector of the Mt. Wilson Observatory, and succeeded in getting the fringes. In order to make the distance between the slits as large as possible, he used two mirrors fastened to a steel beam placed over the objective of the telescope, and reflected the light from them into the telescope which brought the two beams together. When the mirrors were adjusted so that D was 3000 mm the fringes disappeared, whence the diameter of the star was $0''.045$. Taking the distance of Betelgeuse as 200 light years, the linear diameter is found at once to be 265,000,000 miles; or about the size of the orbit of Mars.

Prof. Chant, concluded his lecture by demonstrating the Doppler effect, and explaining its application to the measurement of the radial velocities of stars, especially mentioning the great nebular velocities recently obtained by Slipher.

J. A. Pearce,
Recorder.

AT WINNIPEG

November 17, 1920.—The following were elected to membership in the Society: Mr. E. J. Skafel, B.A.; Mr. Simon Shannon, B.A.; Mr. A. W. Smith; Mr. C. F. Ellis.

Dr. Warren then brought to the attention of the Society the fact of the honor that had been conferred upon Prof. MacLean by his election to Fellowship in the Royal Astronomical Society of Canada. The hearty congratulations of this Centre were then tendered Prof. MacLean.

The Chairman then called upon Prof. MacLean, who gave a lecture on "Time, its Measurement and Distribution". The lecturer stated that equal intervals of time are very excellently determined by the rotation of the earth. This rotation is only *very* slightly affected by celestial, meteorological or geological phenomena,—probably only a small fraction of a second in millions of years. Prof. MacLean then explained the difference between sidereal day and solar day and showed by an excellent set of graphs how the latter varied in length and how

this variation led to an accumulated difference of time between True Solar Time and Mean Solar Time, this difference being called the Equation of Time. The lecturer then explained the need for Standard Time and how this was effected. The lecture closed with the computations in full by the aid of the Ephemeris, of the watch error by means of observation. The unanimous feeling of the meeting was that Prof. MacLean had handled a very intricate and difficult subject in a very simple, clear and helpful manner, making the subject of much interest and profit to all present.

December 1.—Mr. T. W. Stodart was elected a member of the Society.

Mr. Bastin and Prof. MacLean were elected to act as auditors of the Treasurer's books and to bring in a report at the Annual Meeting.

The Chairman then called upon Dr. Miller to give an address on the subject "Is the Earth a Steel Ball?" The lecturer stated that tides are produced in the ocean by the gravitational forces of the sun and the moon, because the ocean is fluid, while the body of the earth is solid. Even a very thick crust could not resist tidal movements in the interior, if the material inside the earth were in a molten, fluid condition. As early as 1863 it was shown by Kelvin that the idea of a molten interior must be abandoned. Nevertheless, the action of volcanoes, the high temperatures in deep mines, and the theory of the formation of the earth by condensation of matter from the gaseous state all lend weight to the idea of a liquid interior, and this idea has lived up to the present time.

The actual yielding of the solid earth to the tidal forces is so small that its amount cannot be inferred from the ocean tides, except that it is very small. To actually measure this small yielding requires special physical measurements on changes in the gravitational vertical, or, what amounts to the same thing, in the position of a true level surface. It also requires elaborate mathematical work to determine just how great these changes would be if the earth were perfectly rigid. This work is based on established astronomical data. The difference between actual observed changes in the vertical, and the changes calculated for a perfectly rigid earth, gives the actual yielding of the earth to the tidal forces. From this yielding and from the known value of the forces, the rigidity of the earth can be calcluated.

Several investigators used the horizontal pendulum to measure the changes in the gravitational vertical. The first experiments were performed in 1880. The results of all the experiments gave for the ratio of actual observed changes to those computed for rigid earth, values ranging from .158 to .643, the most reliable of them being .468 for the east-west direction and .544 for the north-south direction.

Recent measurements have yielded results of very much higher accuracy, and have given much more information regarding the tidal effects in the solid earth than those made with the horizontal pendulum. These experiments were conducted at the Yerkes Observatory by Professors A. A. Michelson and H. G. Gale of the University of Chicago. Pipes six inches in diameter and 500 feet long were buried in the ground in a horizontal position and half-filled with water. The tides in the water were observed and recorded by two different methods.

In each case tides were observed which were very close to 0.7 of those computed for a perfectly rigid earth—and this ratio found to be the *same* in both the east-west and the north-south directions.

The first method of measuring the tides was by means of a micrometer microscope, which measured the distance between a pin-point below the surface of the water, and the reflected image of the pin-point.

The second method of measuring the tides was by means of a special form of Michelson interferometer. This was more accurate and furnished a continuous photographic record of the rise and fall of the tides. A rather large tide would be of the order of .0002 inches. The ratio of observed to calculated tides was found to be .690 with a probable error of 0.6%.

By calculations from this result the coefficient of rigidity of the earth is found to be 8.6×10^{11}, while that of steel is 8.2×10^{11}, in c.g.s. units.

It was found also that the water tides in the pipes were about 4 degrees ahead of the tidal forces, this being caused by the lag of the tides in the solid earth.

References for the foregoing:—Kelvin, *Phil. Transactions of the Royal Society*, 1863; Michelson, *Astrophysical Journal*, March, 1914, and *Science*, October, 1919. Michelson and Gale, *Astrophysical Jour.*, December, 1919.

December 15, 1920.—Prof. C. D. Miller was elected a member of the Society.

Mr. Kolb, the Vice-President, was then asked to take the chair, and at once called upon Prof. Warren who gave an illustrated lecture on "The Bending of Light."

So long as light travels in one medium of uniform density and temperature, it will travel in a straight line. But when light passes obliquely from one medium to another of different density and temperature, the light is bent—*towards* the common perpendicular to the dividing surface if the second medium is denser than the first, and *away from* the common perpendicular, if rarer. When light passes from one medium to a rarer one, there is a certain angle of incidence for which the light will be entirely reflected back into the medium from the dividing surface. For water and air this angle,—which is called the *critical angle*, is 48°. This leads to the very interesting fact that from a point under water, all light coming from above the water will lie within a cone. Some exceedingly interesting pictures taken under water, of objects above the water were then shown. The subject of refraction by the earth's atmosphere was then discussed and various phenomena caused by it; for example, the flattening of the sun and moon when close to the horizon, the amount being about one sixth their diameters at the horizon; the dip and the enlargement of the horizon; the lengthening of the duration of daylight due to refraction, this amounting to *at least* 4m 24s. Defining twilight as the time from sunset until a sixth magnitude star can been seen in the zenith, there emerges the fact that in latitudes above 40° twilight never ends, on June 21st. On the other hand, twilight never lasts over half an hour at the equator. Another curious result of refraction is that sometimes an eclipsed moon may be seen on one horizon while the sun is still visible on the opposite horizon. The lecturer then touched on the refracting telescope and the spectrum.

The lecture throughout was given in a very clear, simple way. At its close an interesting discussion followed in various peculiar phenomena sometimes observed in connection with sun and moon when rising or setting.

H. R. KINGSTON, *Sec.-Treasurer.*

January 12, 1921.—The following were elected to membership of the Society: Mr. F. H. Martin, M.Sc.; G. Shirley Brooks; T. K. Johnston.

An address by Dr. E. M. Burwash followed, on "The Planetesimal Theory of the Earth's Origin", commencing with a short sketch of the Nebular Hypothesis and the varying conclusions drawn from it, also giving arguments in objection to these theories. Darwin's Theory was also dealt with in the same manner. He stated that the Planetesimal Hypothesis is built largely on the question of "Disruption by approach." He enlarged on this principle in a most interesting manner illustrated by several instructive diagrams.

Working on the above assumption, he suggested that the earth was originally much smaller than at present, attaining its present proportions by meteoric secretions and the lighter materials being forced up from the centre of the surface, concluding with some slides illustrating some ancient ideas as to the origin of the earth. In summing up he stated that the Planetesimal Hypothesis was the most satisfactory, at least from a geological standpoint.

January 26.—Two new members were nominated and elected as follows: Miss B. Whillen; Mr. J. F. Mitchell.

A short paper was read by Mr. J. H. Kolb on the Star Algol (The Demon) which was both interesting and instructive.

This was followed by a lecture entitled "Are other Worlds Inhabited?" in which the lecturer, Mr. H. B. Allan, explained that the essential condition of any planet to be considered habitable was that it should contain:—air of a certain density, water, heat within certain temperature limits and light: and that the atmosphere should be of a density and composition to supply the necessary material for respiration and substances for the food for plants upon which all animals depend; also that the surface of the planets should have passed through the necessary chemcial and physical changes, to supply the soil upon which plant life might subsist.

All the planets were subjected to this test and it was pointed out where they failed to come up to the mark.

The conclusion arrived at was that the Moon may have been inhabited but was now a dead world. Mars may still be inhabited, but the probability was that is was very far advanced in planetary evolution if not already at the end of its tether as a habitable world. The articificiality of the dark lines called "Canals" was by no means verified. Venus and Mercury were considered to be in the condition in which the most primitive forms of life might exist and were possibly the next in line for inhabitants, something similar to ourselves, though there were some serious drawbacks mentioned. The giant planets, Jupiter, Saturn, Uranus and Neptune were considered far from being in a habitable condition but in the course of ages would probably become so.

An interesting discussion followed.

C. D. MILLER, *Sec.-Treasurer.*

AT MONTREAL

January 25, 1921.—The following were elected members of the Society:—

H. O. Gowland, Manager of the Gowland Optical Co., Montreal.

M. Waring Davies, Res. Sec. for Canada, of the Royal Academy of Music, Montreal.

Geo. E. Forbes, of Forbes Bros., Montreal.

Rev. Geo. Duncan, D.D., Pastor of the Church of St. Andrew and St. Paul, Montreal.

The principal paper of the evening was given by the President, H. E. S. Asbury, who took for his subject "The Morning and Evening Stars". After briefly reviewing the history of the Montreal Centre, he spoke of the high aims and ideals of astronomy, and prophesied a wonderful future for it. He then described the Morning Stars, Jupiter and Saturn, giving figures on their area, density, etc., and related what was known of their satellites. He next treated the Evening Stars, Mars and Venus, in the same way.

Speaking of the myriads of fixed stars, he reminded his hearers that each one was a sun, presumably encircled by its own planetary system. No telescopes or instruments yet devised were sufficiently powerful to detect these planets, but there was every reason to assume their existance. It was also quite possible and reasonable to assume that life existed in some form on some of them, in view of the fact that life existed and had persisted on this earth in the face of many difficulties.

A brief paper on "The Great Square of Pegasus" written by one of our newest members, Geo. E. Forbes, was read by Mr. Asbury, as Mr. Forbes was unfortunately, through illness, unable to be present. This was written in very charming literary style, and recorded the fancies of the ancient astrologers regarding this constellation.

H. E. MARKHAM,
Recorder.

AT OTTAWA

January 28, 1921.—Mr. A. H. Miller, Dominion Observatory and Mr. F. J. Lambart, Geodetic Survey, Ottawa, were elected members of the Society.

Dr. R. E. DeLury, President of the Centre, then proceeded with his lecture on "Recent Developments in Astronomy". The lecturer outlined briefly the development in recent years of the astronomical instruments, particularly the reflector, making due reference to the 60-inch and 100-inch at the Mount Wilson Solar Observatory and the 72-inch at the Astrophysical Observatory Victoria, B. C. He went on to show how the study of astronomy had advanced by the use of these instruments. Recent investigations of the sun, sun spots and solar magnetic storms were spoken of and how they effect magnetic conditions on the earth. Dr. DeLury referred to the work of Douglass on the growth of trees and sun-spot maxima. The curves of tree growth and sun-spot maxima showed distinctly striking similarity in their periods, which seem to prove that with maximum solar activity we have maximum tree growth.

The conditions that exist in the Novae were considered somewhat similar to what we find in solar outbursts. Dr. DeLury concluded his interesting lecture by a reference to the Einstein theory, speaking of the work done at the time of the recent solar eclipse, when it was found that the stars seemed to suffer an apparent change in position due to the gravitational deflection of the star-light when passing near the sun.

R. J. McDIARMID,
Secretary.

AT VICTORIA

February 1.—Dr. J. S. Plaskett gave a lecture on "The Romance of Astronomy". He admitted that he found it rather difficult to treat as "romance" a subject like astronomy, which is essentially a science of facts and exactitude of measurement. He indicated wherein his difficulty lay when he gave the dictionary definitions of "Romance," selecting as most suitable for the occasion "the character of that which appears strange and charming, also a mental tendency towards or delight in that which is chivalrous, fanciful, or mysterious."

The lecturer's treatment of the subject was partly historical and partly descriptive. The contributions of the Chinese, Hindus, Chaldaeans, Egyptians and Babylonians were considered. The constellations were arranged very much in their present order about 2,800 B.C. The contributions of Pythagoras, Hipparchus and Ptolemy were referred to; the latter prepared the Almagest, "a sort of Astronomical Bible, from which nothing was taken and nothing material added for fourteen centuries."

The work of Copernicus, Tycho Brahe, Kepler, Galileo and Newton was reviewed. The unfolding of the mystery of the world by these men constitutes the great epic of astronomy.

Finally physical astronomy was considered with an outline of the discoveries of Herschel, Adams, Kirchhoff and the other nineteenth century astronomers. The wonders revealed by these men will ever remain a true romance.

K. M. CHADWICK,
Secretary.

"Astronomical Notes" and "Notes and Queries" held over to next month.

The Royal Astronomical Society of Canada

OFFICERS FOR 1921 (Revised to March 1st, 1921).

Honorary President—Hon. R. H. Grant, Minister of Education for Ontario.
President—J. R. Collins. *First Vice-President*—W. E. W. Jackson, M.A.
Second Vice-President—Wm. Bruce, J.P.
General Secretary—A. F. Hunter, M.A. *General Treasurer*—H. W. Barker.
Recorder—J. A. Pearce, B.A. *Librarian*—Prof. C. A. Chant, Ph.D.
Curator—R. S. Duncan.
Council—L. Gilchrist, M.A., Ph.D.; R. A. Gray, B.A.; A. R. Hassard, B.C.L.; H. R. Kingston, M.A., Ph.D.; Otto Klotz, LL.D., D.Sc., F.R.A.S.; Sir Joseph Pope, K.C.M.G.; John Satterly, M.A., D.Sc.; Stuart Strathy; Dr. W. M. Wunder; and past Presidents: John A. Paterson, K.C., M.A.; Sir Frederick Stupart, F.R.S.C.; Prof. A. T. DeLury; Prof. L. B. Stuart; Albert D. Watson, M.D.; J. S. Plaskett, B.A., D.Sc.; A. F. Miller; and the presiding officers of each centre: Ralph E. DeLury, Ph.D., Ottawa; H. E. Asbury, Montreal; Prof. N. R. Wilson, M.A., Ph.D., Winnipeg; J. E. Umbach, Victoria; and R. R. Graham, B.A., B.S.A., Guelph.

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Secretary—R. J. McDiarmid, Ph.D. *Treasurer*—D. B. Nugent, M.A.
Council—F. Henroteau, Ph.D.; E. A. Hodgson, M.A.; J. P. Henderson, M.A.; and past Presidents: Otto Klotz, LL.D., D.Sc.; R. M. Stewart, M.A.; F. A. McDiarmid, M.A.; J. J. McArthur, D.L.S.; and C. A. Bigger, D.L.S.

MONTREAL CENTRE

President—H. E. S. Asbury. *Vice-President*—E. E. Howard, K.C.
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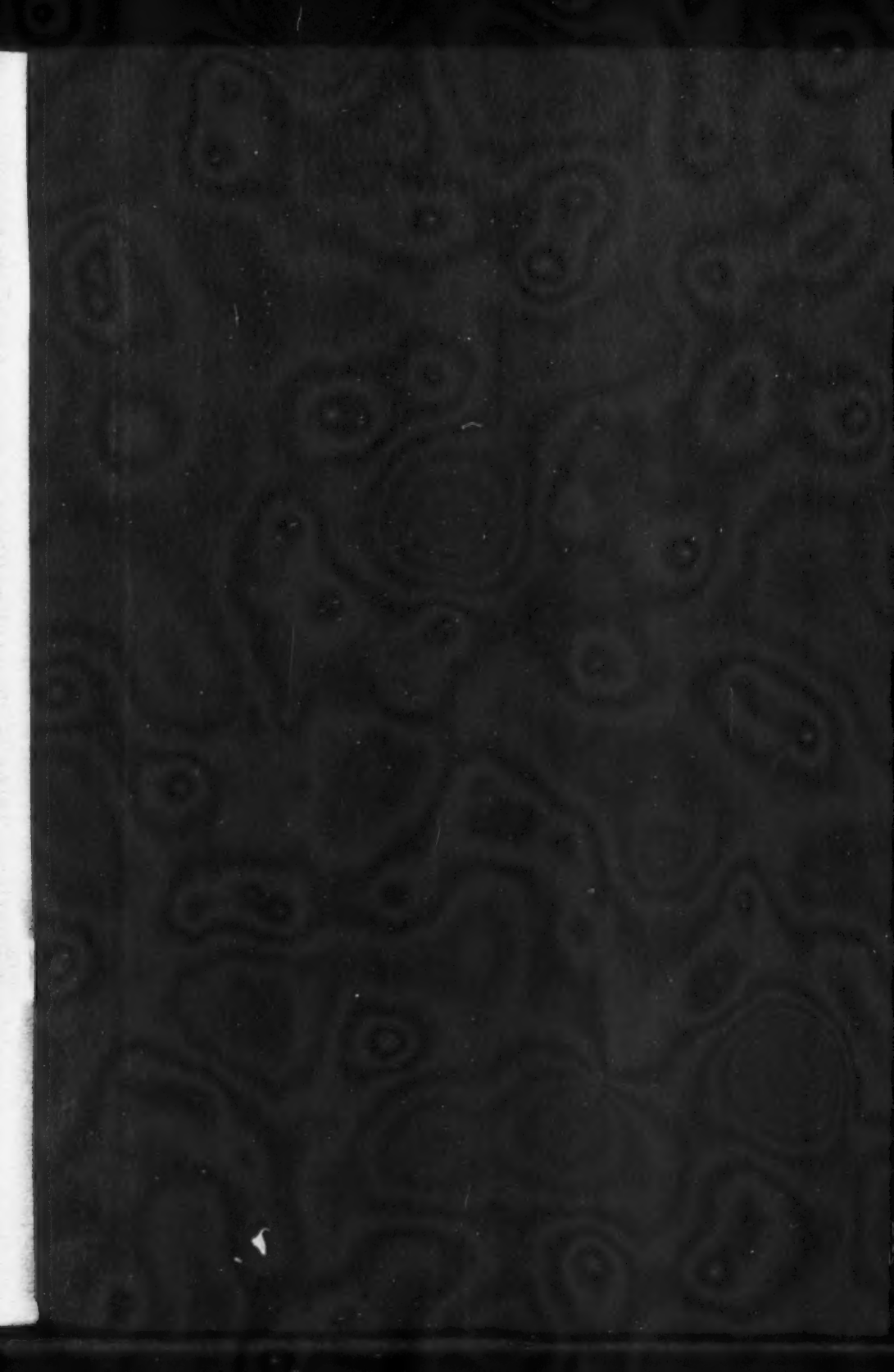
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